

1   Claims

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3   1. An electrochemical sensor comprising:  
4   an electrochemical cell having a sensor means;  
5   fluid flow control means positioned so as to release a  
6   fluid jet onto the sensor means, the fluid flow control  
7   means having means for controlling the velocity of the  
8   fluid jet, the fluid flow velocity being defined by the  
9   Reynolds number of the fluid when the fluid is in the  
10   fluid flow control means; and  
11   wherein control of the Reynolds number and measurement of  
12   the electrical output of the sensor provide a measure of  
13   the build-up of scale on the working electrode.

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15   2.    An electrochemical sensor as claimed in claim 1  
16   wherein, the measure of scale build up quantifies the  
17   scale build up on the sensor surface in the  
18   electrochemical cell.

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20   3.    An electrochemical sensor as claimed in claim 1  
21   wherein, the sensor detects scale build up to measure the  
22   scaling tendency of the fluid.

23

24   4.    An electrochemical sensor as claimed in any  
25   preceding claim wherein, the fluid control means is a  
26   conduit provided with a control valve or pump.

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28   5.    An electrochemical sensor as claimed in any  
29   preceding claim wherein, the sensor measures the change  
30   in electrical output as a function of Reynolds Number  
31   during use of the fluid flow control means

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1 6. An electrochemical sensor as claimed in any  
2 preceding claim wherein, the electrical output  
3 measurement means measures the limiting current response  
4 of the sensor as a function of Reynolds Number.

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6 7. An electrochemical sensor as claimed in any preceding  
7 claim, wherein the fluid flow control means is a conduit  
8 having a predefined diameter (d) and is positioned at a  
9 height (H) above the sensor having a radius (r).

10

11 8. An electrochemical sensor as claimed in claim 7  
12 wherein laminar flow of the fluid from the fluid control  
13 means is provided by setting said diameter (d), height  
14 (H) and radius (r).

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16 9. An electrochemical sensor as claimed in claim 7  
17 wherein  $H/d = 1$ ; and  $r/d < 0.5$ .

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19 10. An electrochemical sensor as claimed in any  
20 preceding claim further comprising fluid sampling means  
21 for obtaining a sample of a test fluid.

22

23 11. An electrochemical sensor as claimed in any  
24 preceding claim wherein, the fluid sampling means  
25 contains fluid isolation means for isolating the test  
26 fluid from a bulk fluid.

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28 12. An electrochemical sensor as claimed in claim 8  
29 wherein , the fluid isolation means is provided by a  
30 container having at least one sealable valve which, when  
31 opened, allows the test fluid to enter the sampling  
32 means.

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1 13. An electrochemical sensor as claimed in any  
2 preceding claim wherein, the fluid flow control means  
3 comprises a flow meter or flow sensor for measuring flow,  
4 connected to a conduit from which said fluid jet is  
5 expelled.

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7 14. An electrochemical sensor as claimed in any  
8 preceding claim wherein, the sensor comprises a working  
9 electrode, a counting electrode and a reference  
10 electrode.

11  
12 15. An electrochemical sensor as claimed in any  
13 preceding claim wherein, the electrochemical sensor  
14 further comprises a reservoir for storing a second, pre-  
15 prepared electrolyte, flow control means and one or more  
16 conduits connected to the electrical cell such that the  
17 pre-prepared electrolyte is used with the electrical cell  
18 to measure the quantity of scale deposited by the test  
19 fluid by measuring the electrical output of the cell as a  
20 function of Reynolds number.

21  
22 16. An electrochemical sensor as claimed in claim 15,  
23 wherein the electrolyte is a solution.

24  
25 17. An electrochemical sensor as claimed in claim 15 or  
26 claim 16 wherein, the electrolyte is a solution of brine  
27 containing a suitable tracer.

28  
29 18. An electrochemical sensor as claimed in claim 17  
30 wherein the tracer is ionic.

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32 19. An electrochemical sensor as claimed in claim 17  
33 wherein the tracer is oxygen.

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2 20. An electrochemical sensor as claimed in claims 15 to  
3 19 wherein, the pre-prepared solution has a saturation  
4 ratio of less than 1.

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6 21. An electrochemical sensor as claimed in claims 15 to  
7 20 wherein, the pre-prepared solution has a saturation  
8 ratio of greater than 1.

9

10 22. A method of measuring the scaling properties of a  
11 test fluid, the method comprising the steps of:  
12 controlling the velocity of a fluid jet as defined by the  
13 Reynolds number of the fluid when the fluid is in a fluid  
14 flow control means;  
15 releasing the fluid jet from the fluid control means onto  
16 a sensor of an electrochemical cell; and  
17 measuring the electrical output from the sensor as a  
18 function of the Reynolds number of the jet fluid, the  
19 sensor being in contact with a sample of the test fluid.

20

21 23. The method of claim 20 wherein, the sensor gives a  
22 measure of the change in electrical output as a function  
23 of Reynolds number during use of the fluid flow control  
24 means.

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26 24. The method of claim 22 or 23 wherein, the electrical  
27 output provides a measure of the limiting current  
28 response of the electrochemical cell as a function of  
29 Reynolds Number.

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31 25. The method of claims 22 to 24, wherein the fluid flow  
32 control means is a conduit having a predefined diameter

1 (d) and is positioned at a height (H) above the working  
2 electrode or sensor having a radius (r).

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4 26. The method of claim 25, wherein laminar flow of the  
5 fluid from the fluid control means is provided by setting  
6 said diameter (d), height (H) and radius (r).

7

8 27. The method of claim 25 or claim 26 wherein  $H/d = 1$ ;  
9 and  $r/d < 0.5$ .

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11 28. A method as claimed in claims 22 to 27 comprising  
12 the further step of isolating the test fluid from a  
13 flowing fluid prior to measuring the electrical output  
14 from the electrical cell as a function of the Reynolds  
15 number of the fluid.

16

17 29. A method as claimed in claim 28 wherein, the test  
18 fluid is isolated by closing valves arranged upstream and  
19 downstream of a predetermined measuring location in a  
20 sample measuring means.

21

22 30. A method as claimed in claims 22 to 29 wherein the  
23 fluid is isolated by removably attaching a sampling  
24 conduit to a first conduit in which the bulk of the fluid  
25 is situated, and by providing valves to isolate the  
26 sampling conduit from the first conduit.

27

28 31. A method of measuring the scaling properties of a  
29 test fluid, the method comprising the steps of:  
30 introducing a jet of test fluid into an electrochemical  
31 cell so as to allow scale to build up on one or more  
32 surfaces in the cell;  
33 removing the test fluid from the electrochemical cell;

1 introducing a pre-prepared solution into the cell; and  
2 measuring the electrical output from the electrochemical  
3 cell.

4

5 32. A method as claimed in claim 31 wherein, the test  
6 fluid is introduced into the electrochemical cell at a  
7 rate defined by the Reynolds Number of the fluid when  
8 contained in a first fluid control means.

9

10 33. A method as claimed in claim 31 or claim 32 wherein,  
11 the pre-prepared solution is introduced into the  
12 electrochemical cell at a rate defined by the Reynolds  
13 number of the fluid when contained in a second fluid  
14 control means.

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16 34. The method of claims 31 to 33 wherein, the  
17 electrical output measures the change in electrical  
18 output as a function of Reynolds Number during use of the  
19 fluid flow control means.

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21 35. The method of claims 31 to 34 wherein, the  
22 electrical output provides a measure of the limiting  
23 current response of the electrochemical cell as a  
24 function of Reynolds Number.

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26 36. The method of claims 31 to 35, wherein the fluid flow  
27 control means is a conduit having a predefined diameter  
28 ( $d$ ) and is positioned at a height ( $H$ ) above the working  
29 electrode or sensor having a radius ( $r$ ).

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31 37. The method of claim 36, wherein laminar flow of the  
32 fluid from the fluid control means is provided by setting  
33 said diameter ( $d$ ), height ( $H$ ) and radius ( $r$ ).

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2 38. The method of claim 36 or claim 37 wherein  $H/d = 1$ ;  
3 and  $r/d < 0.5$ .

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5 39. A method as claimed in any of claims 36 to claim 38  
6 wherein, the pre-prepared solution has a saturation ratio  
7 of less than 1.

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9 40. A method as claimed in any of claims 36 to claim 39  
10 wherein, the pre-prepared solution has a saturation ratio  
11 of greater than 1.

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